Postoperative Hemorrhage after Pulmonary Resection*

I. Comparison of secondary thoracotomy and conservative treatment

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One of the early and dangerous complications of pulmonary resection is hemorrhage. According to the literature, the frequency of this complication has been reported variously from 0.5 to 4 per cent of operations. A considerable proportion of hemorrhages end fatally. Hemorrhages after pulmonary resection may be the result of blood coagulation disorders, including fibrinolysis; more often, however, they are caused by opened blood vessels or multipunctate bleeding.

Provided laboratory studies exclude the first possibility, the procedure of choice in our clinic has been rethoracotomy and control of the bleeding by routine methods in surgery. After spontaneous cessation of bleeding, either by compression of the site of hemorrhage by a blood clot or by clotting, if a large hematoma is demonstrable radiographically in the thorax, rethoracotomy is performed to remove the clot and liquid blood.

This active approach, as a rule, has been adopted on the basis of many years of experience in the treatment of hemorrhage after pulmonary resection. An attempt to justify this attitude by statistical analysis of the results of rethoracotomy has now been made. Nevertheless, conservative treatment also has its advocates, and until 1957 in this Clinic rethoracotomy was seldom done (Fig. 7), the loss of blood being replaced by massive transfusion.

The purpose of this study was to compare the therapeutic results in groups of patients treated conservatively and by rethoracotomy. In the available literature we have not been able to find a similar comparison of the two methods. The factors influencing the frequency of postoperative hemorrhage and the therapeutic results were also studied.

Method and Material

The study material consisted of all cases of rethoracotomy performed up to the sixth day after pulmonary resection, either because of hemorrhage or intrapleural hematoma, in which the rhythm bleeding and amount of blood lost by the patient conformed to one of the indications for rethoracotomy.

On the basis of these criteria, 92 cases of hemorrhage were selected for analysis from 2256 pulmonary resections for pulmonary tuberculosis, tumors, pulmonary abscess,

Table 1—Extent of Resection and Postoperative Hemorrhage with Reference to Types of Procedure Carried Out.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number Operations</th>
<th>Number Hemorrhages (Per Cent)</th>
<th>Number Secondary Thoracotomy (Per Cent)</th>
<th>Per Cent Secondary Thoracotomy in Hemorrhages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonectomy</td>
<td>317</td>
<td>21 (6.9)</td>
<td>18 (4.6)</td>
<td>53</td>
</tr>
<tr>
<td>Lobectomy</td>
<td>897</td>
<td>34† (3.8)</td>
<td>18‡ (2.0)</td>
<td>53</td>
</tr>
<tr>
<td>Segmentectomy</td>
<td>735</td>
<td>27 (3.7)</td>
<td>19 (2.6)</td>
<td>70</td>
</tr>
<tr>
<td>Mechanical resection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UKL ap.</td>
<td>307</td>
<td>10 (3.2)</td>
<td>6 (2.0)</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>2256</td>
<td>92 (4.1)</td>
<td>57 (2.5)</td>
<td>62</td>
</tr>
</tbody>
</table>

†25 cases with simultaneous thoracoplasty.
‡14 cases with simultaneous thoracoplasty.
bronchiectases, mycosis, etc. from November, 1949 through December, 1962, constituting 4.1 per cent of the cases. In 57 cases, rethoracotomy was performed, and in 35 the hemorrhage was controlled conservatively.

The extent of the operation was not invariably related to the frequency of hemorrhage. Significantly different frequencies of hemorrhage after mechanical dm with the UKL apparatus, segmentectomies and lobectomies were not observed. It is worth noting that after lobectomies, during which an anatomic unit of the lung is removed, hemorrhage was observed mainly in cases in which simultaneous thoracoplasty was done (Table 1). Hemorrhage was clearly related only to pneumonectomies, as a result of costopleuroneumonectomy (Table 1), which has not been separated into a special group.

The choice between conservative and active treatment of hemorrhage was not related to the type of primary operation performed. In all types of resection, rethoracotomy was performed in 60 to 70 per cent of cases of hemorrhage.

For the sake of brevity, the following designations will be used:

Group I—patients in whom the hemorrhage was controlled by active procedures, i.e. by rethoracotomy (57 patients).

Group II—patients in whom hemorrhage was treated conservatively (35 patients).

It should be emphasized that the mean loss of blood in the two groups differed insignificantly: 2033±320 ml. in group I, and 1920±276 ml. in group II.

The difference between group I and group II were studied, taking into account factors responsible for bleeding, such as: (1) the layer in which the lung was dissected, (2) duration of operation, (3) amount of blood transfusion given during operation.

In many cases more than one of these factors was present.

In 76 per cent of cases, the lung had been dissected in the extrapleural layer/
bleeding surface from the thoracic wall, diaphragm, mediastinum, or decorticated surface of the lung. In this respect, group I did not differ from group II.

Hemorrhages were observed more often after operations of longer duration, i.e. after difficult operations with tedious dissection. In some cases, toward the end of operations lasting three and one half hours or longer, the patient's condition necessitated hasty closure of the thorax, and hemostasis may have been less exact. However, hemorrhages were observed also after operations lasting only one and one half hours with free pleural cavity and intrapleural dissection of the lung, in which hemostasis was carefully attended to. In such cases, rethoracotomy was performed in a majority of cases (Fig. 1), since it was considered that bleeding cannot be multipunctate in character but that its source must be damaged blood vessel. This assumption was usually confirmed during rethoracotomy by finding bleeding vessels which, having contracted during the operation, had been overlooked.

It was assumed that the amount of blood transfused during operation compensates for the amount of blood lost by the patient. In the past two years, blood transfusion has been guided by weighing the blood loss. Transfusion of excessive amounts of preserved blood is thought to affect postoperative bleeding unfavorably. The analysis shows (Fig. 2) that by increasing the amount of preserved blood transfused, the percentage of patients in whom bleeding time and clotting time are normal after operation is decreasing.

Considerable loss of blood may lead to hemorrhagic shock because it is not always possible to compensate for the massive operative bleeding. Shock or delay in the transfusion of blood leads to drop in blood pressure.
pressure during hemostasis and closure of the thorax, as a result of which not excessively bleeding or smaller blood vessels may be overlooked.

As can be seen in Fig. 3, the greatest percentage of cases with postoperative hemorrhage pertains to patients who received transfusions of large amounts of blood during resection, i.e. who suffered large doses.

Groups I and II are composed equally of severely ill patients and can be regarded as comparable. The early operative results in groups I and II can therefore be compared. The comparison of the early postoperative results covers a three-month period of observation. The following factors were taken into account:

1. frequency of complications, non-specific empyema, bronchial fistula, suppurition and dehiscense;
2. loss of vital capacity;
3. re-expansion of the lung;
4. mortality rate.

It can be seen in Fig. 4 that conservative treatment of hemorrhage, usually leading to the development of a clot, in 31.4 percent of cases, was followed by nonspecific empyema in the postresection space. On the other hand, the percentage of empyema in the group of rethoracotomies differs only slightly from the overall percentage in the material of resected patients.

The frequency of bronchial fistulas after rethoracotomies was not greater than in the whole material of pulmonary resections or compared with the group of conservatively treated patients.

Suppurition or dehiscence of the operative wound also were not more frequent.
Since thoracotomy always constitutes a potential source of infection, these results are noteworthy. It may be recalled that five patients had thoracotomy performed three times because of hemorrhage.

The mean vital capacity three months after pulmonary resection was compared with the mean vital capacity before operation, and the percentage or loss was calculated. Pneumonectomy cases were excluded. The patients were classified according to the extent of the operation. In group II, not operated by secondary thoracotomy, the loss of vital capacity after operation, regardless of its extent, was greater than in group I, especially after less extensive operations.
When observing re-expansion of the lung, cases which had one-stage thoracoplasty were excluded and the following criteria were adopted: (1) favorable re-expansion (in standard radiograms the apex reaches to the level of the third posterior rib or higher); (2) moderate re-expansion (residual air space present, requiring aspiration or secondary drainage, residual space which disappeared spontaneously within 3 to 12 weeks); (3) poor re-expansion (residual space persisting 12 weeks or longer or necessity of secondary thoracoplasty to obliterate the space).

Postoperative complications, such as incomplete re-expansion, were much greater after conservative treatment of hemorrhages than after secondary rethoracotomy (Fig. 6). This conclusion is seen to be logical when the mean percentage of loss of vital capacity after resection in the two groups is compared (Fig. 5).

The results of the analysis of re-expansion of the lung after postoperative hemorrhages show that rethoracotomy, even when necessary two or three times, is less detrimental to the re-expansion of the lung than presence of hematoma in the pleural cavity, especially in its lower part.

Finally, a very important point remains to be mentioned. The death rate after hemorrhage has decreased markedly since rethoracotomy has become routine procedure (Fig. 7). Before 1956, only one rethoracotomy was performed in 22 cases of persistent hemorrhage, and the mortality at that time was 45 per cent. Since 1957, i.e. since we have been performing rethoracotomy routinely in cases of postoperative hemorrhage, the mortality rate has decreased almost sixfold.

The overall mortality rate of conservatively treated hemorrhages has been 28 per cent, and in cases treated by rethoracotomy, only 7 per cent. The difference is statistically significant.

**Summary**

(1) Postoperative hemorrhage after pulmonary resection is more frequent when the lung is dissected extrapleurally, the operation is protracted, and large amounts of blood are transfused.

(2) The mortality rate after conservative treatment is four times and nonspecific empyema five times more frequent than after rethoracotomy. The differences in both cases are statistically significant.

(3) The postoperative loss of vital capacity is greater after hemorrhages treated conservatively.

**Resumen**

1. La hemorragia post-operatoria después de la resección pulmonar es más frecuente cuando se practica la disección extrapleural del pulmón o cuando la operación es prolongada o se transfunde gran cantidad de sangre.

2. La mortalidad del tratamiento conservador es cuatro veces mayor y la incidencia del empiema no específico cinco veces más frecuente que después de la retoracotomía. La diferencia en ambos casos es estadísticamente significativa.

3. La pérdida post-operatoria en la capacidad vital es mayor cuando la hemorragia es tratada conservadoramente.

**Résumé**

1. L'hémorragie post-opératoire après extrérité est plus fréquente quand l'opération est longue et quand de grandes quantités de sang sont transfusées.

2. Après traitement médical les chances de mortalité sont 4 fois plus fréquentes et les empyème non spécifiques 5 fois plus fréquents qu'après réintervention par thoracotomie. Les différences dans les deux cas sont statistiquement significatives.

3. La diminution post-opératoire de la capacité vitale est plus élevée après les hémorragies traitées médicalement.

**Zusammenfassung**

1. Eine postoperative Blutung nach Lungenresektion tritt häufiger auf wenn die Lunge extrapleural durchtrennt wird, wenn die Operation überdurchschnittlich lango dauerhat und wenn große Blutmengen transfundiert wurden.

2. Die Mortalität nach konservativer Behandlung ist um das Vierfache bei unspezifischen Empyem um das Fünffache häufiger als nach thoracotomie. Die Differenzen in beiden Fällen sind statistisch signifikant.

3. Der postoperative Verlust an Vitalkapazität ist nach konservativ behandelten Blutungen größer.
HEMORRHAGE AFTER PULMONARY RESECTION

REFERENCES

TUBERCULOSIS AND ICTERIC HEPATITIS

A study of 259 cases of pulmonary tuberculosis showing icteric hepatitis in the course of treatment is presented. It seems that jaundice has a favorable action on the course of pulmonary tuberculosis and biliary salts seem to be the main agents in this process through their anti-inflammatory, cortisone-like and chemical properties which may exert a nonspecific desensitizing action. Decrease of positivity in tuberculin tests noticed in connection with the improvement of the pulmonary condition shows that there is no reduction of immunologic potentials in pulmonary tuberculosis patients with icteric hepatitis.


ACUTE MITRAL REGURGITATION

This report describes the clinical, radiographic, hemodynamic and pathologic findings in ten patients, in each of whom ruptured mitral chordae tendineae were responsible for severe mitral regurgitation. In six patients, the chordal rupture was the result of proved bacterial endocarditis, and in the other four, although the cause was not determined, it is considered that bacterial endocarditis may have been the etiologic factor in them as well. Only one of the patients had a history suggestive of acute rheumatic fever. The signs and symptoms of mitral regurgitation appeared abruptly in all but one patient and were unrelenting thereafter. Eight patients had sinus rhythm and two had atrial fibrillation. Each of the latter had had symptoms of cardiac decompensation for several years, and their left atria were markedly enlarged. The left atrial chamber in the other eight patients was of near normal size or only moderately enlarged.

Mitrall anuloplasty was performed in two patients, with insertion of artificial chordae, but both died in the early postoperative period. Replacement of the mitral valve with a Starr-Edward prosthesis was performed in five patients, with considerable improvement in four. The fifth died of a pulmonary complication two weeks after operation. The distinctive clinical and hemodynamic findings in the majority of these patients, i.e., the rapid progression of heart failure, sinus rhythm, normal-sized or only moderately enlarged left atria, and the greatly elevated pressures in the pulmonary artery and left atrium are attributed to the sudden onset of the mitral regurgitation. These findings are contrasted to those in patients with chronic rheumatic mitral regurgitation, whose disability progresses slowly and who exhibit atrial fibrillation, marked left atrial enlargement, and sometimes normal pulmonary arterial and left atrial pressures. It is proposed that the majority of patients with ruptured chordae cannot sustain the acutely imposed hemodynamic burden for periods of time sufficient to allow the increase in left atrial compliance so frequently observed in patients with chronic rheumatic mitral regurgitation.


CONFERENCE ON RESPIRATORY THERAPY

The third annual Conference on Respiratory Therapy will be held on November 9-12, 1966 at the Sheraton Boston Hotel, Boston, under the sponsorship of the Lahey Clinic Foundation, Children's Hospital Medical Center and New England Deaconess Hospital.

Wednesday, November 9 will be devoted to Workshops on Ventilators, Blood Gas Analysis, Humidification and Pulmonary Function Testing.